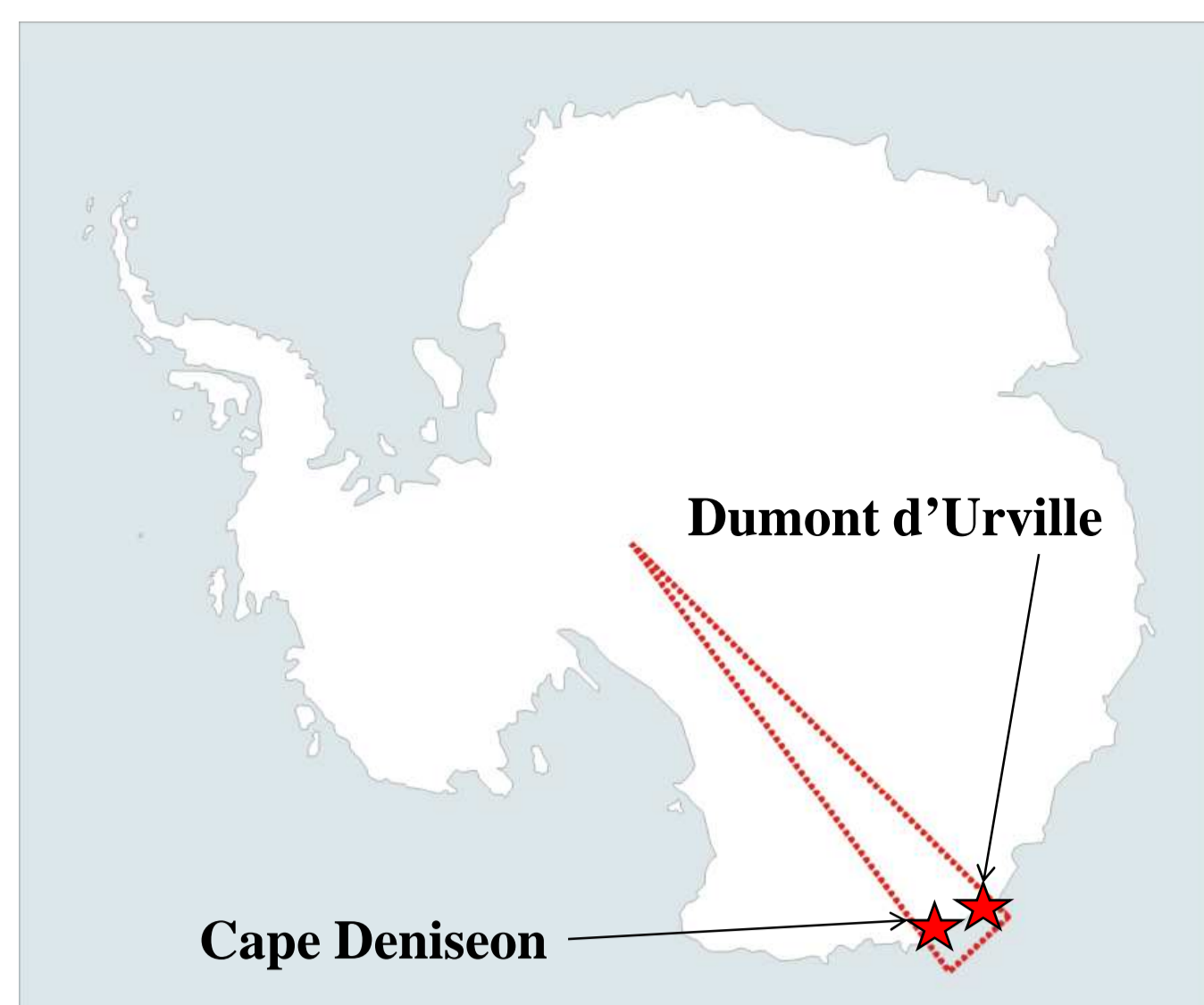


# Estimating long term sea level trends in East Antarctica

Testut, L.<sup>(1)</sup>, Coleman, R.<sup>(2)</sup>, Broksma, H.<sup>(3)</sup>, Watson, C.<sup>(4)</sup>, Handsworth, R.<sup>(3)</sup>, Calzas, M.<sup>(5)</sup>

- (1) LEGOS, Toulouse (France). Contact: [laurent.testut@legos.obs-mip.fr](mailto:laurent.testut@legos.obs-mip.fr)  
 (2) Centre for Marine Science, University of Tasmania (Australia).  
 (3) Australian Antarctic Division, Tasmania (Australia).  
 (4) Surveying and Spatial Science Group, University of Tasmania (Australia).  
 (5) Division Technique de l'INSU, Brest (France).



## Cape Denison: Historic and modern sea level observations

The Australasian Antarctic Expedition (AAE), led by Sir Douglas Mawson, explored part of the East Antarctic coast between 1911 and 1914. The AAE spent the winter of 1912 and 1913 in a station built in Commonwealth Bay, Cape Denison. During this period a series of routine scientific and meteorological observations were undertaken, including the deployment of a mechanical float (Halligan type) tide gauge. The gauge was installed on fast ice in Boat Harbour, Commonwealth Bay and observed 98 days of sea level between June 3rd and September 9th, 1912. The sea level was tied to a benchmark on the rock, which is still present and located near Mawson's original huts (cf. Figure 1). The original tide gauge charts have been found in the Mitchell Library, Sydney, Australia.

As part of a collaboration between French and Australian teams, two bottom pressure gauges have been installed in Boat Harbour (a few tens of meters from the historical gauge location) during the French NIVMER-08A expedition in January 2008 (Testut et al., 2008). The pressure gauges have been tied to the original tide gauge benchmark through the use of a GPS buoy technique (Watson et al., 2008) and traditional precise leveling.

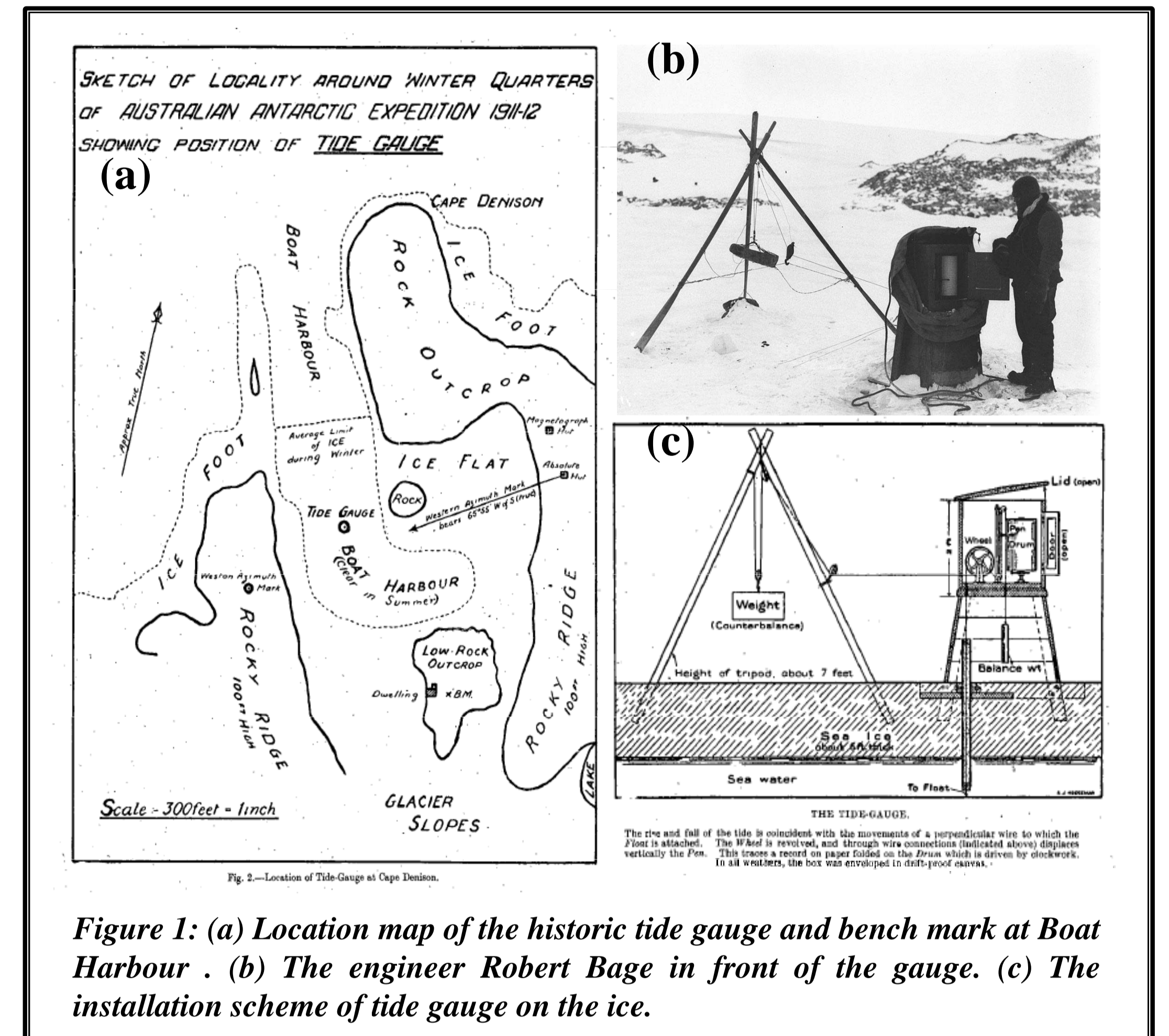


Figure 1: (a) Location map of the historic tide gauge and benchmark at Boat Harbour. (b) The engineer Robert Bage in front of the gauge. (c) The installation scheme of tide gauge on the ice.

## Progress to date at Cape Denison:

The main objective of this experiment is to assist in filling a striking information void by computing the sea level trend relative to the land over the period 1912-2008. The 2 pressure gauges will be deployed for a total of 2-3 years in order to compute a modern day estimate of mean sea level, and begin to understand the interannual variability at this location. The GPS buoy data will be used to calibrate and define the datum connection to both pressure gauges (cf. Figure 2), and will be repeated on the recovery of the gauges. The preliminary results from the first GPS buoy deployment show a clear seiche signal with a period of ~6 minutes and amplitude of ~1cm. This seiche was also observed at the time of the AAE observations, and discussed in the historical analysis of the records made by Doodson (Doodson, 1939). Careful analyses of the original sea level data, the leveling connections and the modern pressure gauge data will allow the computation of a trend estimate over almost a 100 year period - the longest such record in Antarctica.

## Progress to date at Dumont d'Urville:

A preliminary estimate of sea level rise relative to the land, computed from all available monthly means at Dumont d'Urville (except dubious data from 1987) is +1.8 mm/yr (cf. Figure 3). This result is preliminary and a thorough check of all observations, datum connections and assessment of inter-annual variability and other error contributions is still required.

### Acknowledgment:

The authors wish to thank the French polar institute (IPEV) and the crew of l'Astrolabe for providing logistic support during the NIVMER-08 campaign. People from the Mawson's Huts Foundation expedition (2007-08) led by P. McCabe are heartily thanked for their hospitality at Cape Denison and assistance with leveling activities and the tide gauge deployment as well as Roger Handsworth from AAD for the design and construction of the pressure gauge and training of Mawson's Hut Foundation personnel. Benoit Legresy and the CRAC-ICE program are also thanked for the support with the GPS installation. The Mitchell Library is thanked for assistance with historic AAE records.

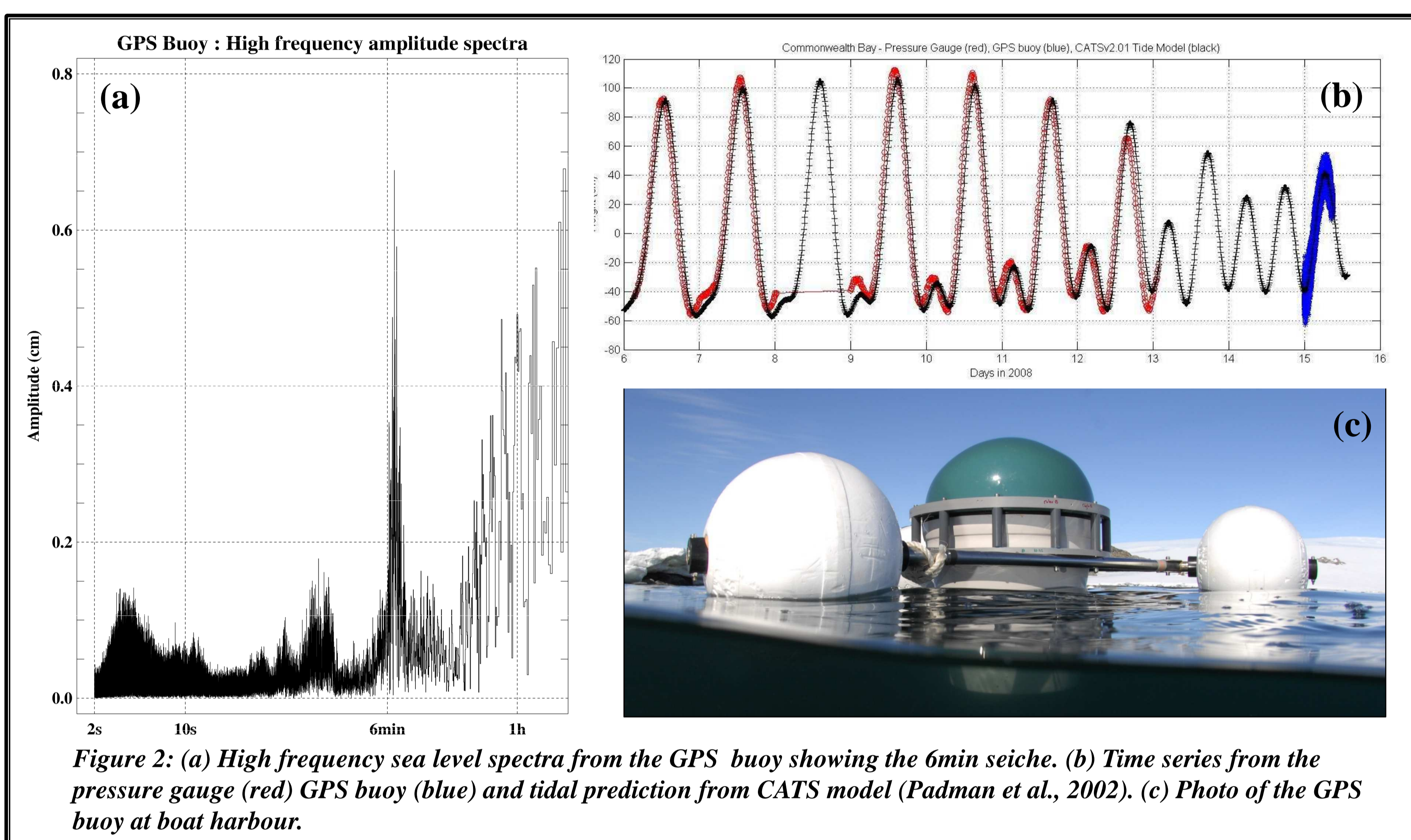


Figure 2: (a) High frequency sea level spectra from the GPS buoy showing the 6min seiche. (b) Time series from the pressure gauge (red) GPS buoy (blue) and tidal prediction from CATS model (Padman et al., 2002). (c) Photo of the GPS buoy at boat harbour.

## Dumont d'Urville : Historic and modern sea level observations

In 1947 the EPF (French Polar Expedition), led by P.E. Victor, was created and charged to organize scientific expeditions in both Arctic (Greenland) and Antarctica (Terre Adelie land). During 3 years (1950-1952) EPF made sea level measurements at Port-Martin and Dumont d'Urville station (Terre Adelie). Many of these early measurements were found in the archive of the French Hydrographic Service (SHOM). Sea level data was also observed at Dumont d'Urville during the International Geophysical Year of 1957. Then French scientists and gouvernement showed a loss of interest over about 30 years with respect to the study of tides and sea level variability in the polar regions (cf. Testut et al. 2005). This was overcome in the early 1990's, most probably due to the catalyst of being involved in future satellite altimetry programs. In 1997 a permanent GLOSS station was installed at Dumont d'Urville in the frame of the French ROSAME network (cf. <http://www.legos.obs-mip.fr/en/observations/rosame/>)

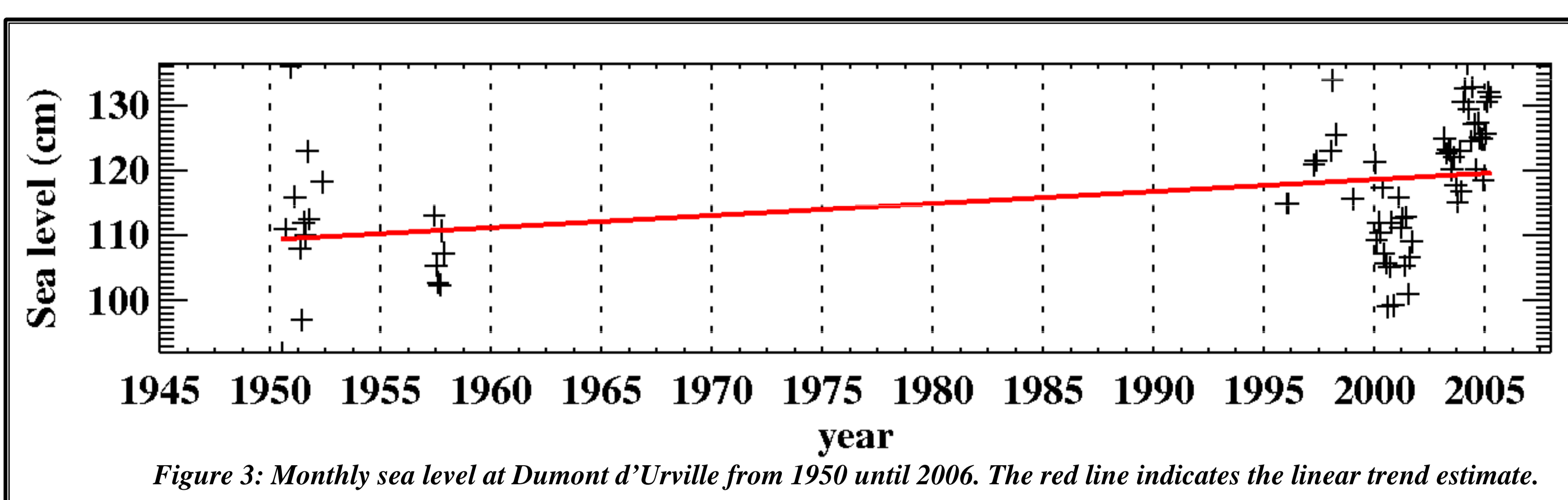
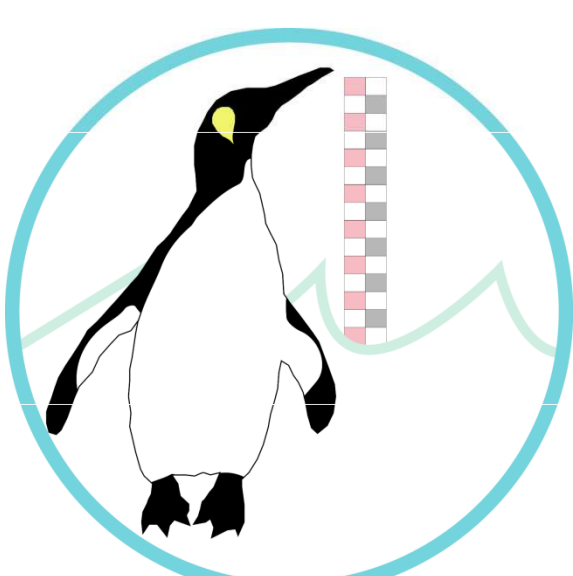


Figure 3: Monthly sea level at Dumont d'Urville from 1950 until 2006. The red line indicates the linear trend estimate.

### References

- Doodson, AT 1939, *Oceanography Part 2: Tidal Observations*, Scientific Reports from the Australasian Antarctic Expedition 1911-1914. Series A, Vol 2, Australian Government Printers, Sydney, Australia, pp. 61-85.  
 Padman, L., H. A. Fricker, R. Coleman, S. Howard, and S. Erofeeva. (2002). A new tidal model for the Antarctic ice shelves and seas, *Ann. Glaciol.*, 34, 247-254.  
 Testut L., Calzas M. (2008) Campagne Nivmer-08 R2. Available at <http://www.legos.obs-mip.fr/en/observations/rosame/communication/rapports/>  
 Testut L., G. Wüppelmann, B. Simon, P. Téchiné (2005) The Sea Level at Port-aux-Français, Kerguelen Island, from 1950 to the present. *Ocean Dynamics* Vol. 56, N5-6, doi 10.1007/s10236-005-0056-8.  
 Watson C.S., Coleman R., Handsworth R. (2008). Coastal tide gauge calibration : a case study at Macquarie Island using GPS buoy techniques. *Journal of Coastal Research*: 24(4). DOI: 10.2112/07-0844. (In Press)



INSTITUT NATIONAL  
DES SCIENCES  
DE L'UNIVERS

